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JUDGING THE QUALITY AND FRESHNESS OF FISH BY ORGANOLEPTIC METHODS[1/]

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Fish are among the most perishable of all foodstuffs and accordingly in the sale and distribution of this food it is important to have testing methods for distinguishing with reasonable accuracy various degrees of freshness. Such tests are of value in the sale of fish by the fishermen, in various intermediate transactions between producers, wholesalers, and retailers, and in ultimate purchase of the fish by the homemaker.

Quality in fish.---Before discussing the various methods for determining freshness of fish it will be well to establish just what properties constitute quality in fish. Although such criteria as clear eyes, bright red gills, etc., are often used as indications of the freshness of fish, actually the ultimate consumer is primarily interested in only the three properties, keeping quality after purchase, appearance and odor during preparation, and palatability of the cooked fish.

Keeping quality after purchase.---If fish is purchased for immediate consumption the keeping quality need not be given as much consideration as when it must be kept for a day or two before cooking. Fish are frequently purchased in the morning and placed in the household refrigerator until evening, or the following day. Prior to sale, the fish was kept in crushed ice at a temperature not much above 32° F. and when removed from the ice for delivery, the temperature immediately rises, oftentimes considerably, since no attempt is made to refrigerate it during delivery.

The spoilage rate of fish is dependent upon a number of factors. The rate of spoilage increases greatly with increasing temperatures, so the rate of decomposition of fish stored at the temperature of the average household refrigerator is about four times as great as that of fish kept well-iced. For example, a fish which would remain in good condition for 36 additional hours if kept in ice at the retail store would keep only about 9 hours in a refrigerator in the home. The keeping quality of the fish after sale to the consumer is of considerable importance, since it is not so much the condition of the fish when purchased as the condition of the fish several hours later which is of most importance. Therefore, buyers at the fishing wharf will want to be certain that the fish which they buy from the fishermen not only are of high quality at the time of purchase, but also that they will keep in good condition until they reach the ultimate consumer.

1/Replaces Fishery Market News Separate 31.

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Appearance and odor during preparation.--A fish of high quality must have an appetizing appearance, especially during preparation. Of even more importance is the presence or absence of decomposition odors during preparation and cooking of the fish. Many fish give off a stale or putrid odor during cooking, yet have no bad odor or flavor when eaten. The bad odors had been driven off during cooking and anyone present during preparation may not relish the fish when served. Many people are under the impression that this condition is always encountered whereas only fish of inferior quality give off bad odors during cooking.

Factors affecting palatability.--Palatability is determined by numerous factors, the more important of which are:(1) Normal flavors and odors. (2) Satisfactory texture. (3) Good appearance of cooked fish.

Each species of fish contains various aromatic substances which give the flesh its characteristic flavor and odor. Moreover, fish contain numerous mineral substances which not only contribute to the flavor, but add considerably to its nutritive value. When fish are not handled properly, a portion of these substances may be lost, and such fish are not of high quality. Anyone can distinguish fish having a stale odor, but what is not so generally recognized is that an aftertaste left in the mouth after eating is due to poor quality fish. An aftertaste usually is caused by rancid oil and is not present when high quality fish have been eaten.

The texture of flesh should be tender, firm, and moist. In many species of fish, the flesh falls apart in flakes when cooked, but this is not a characteristic common to all fish. Various abnormal textures are sometimes observed such as stringy, rubbery, jelly like, or tough. While these characteristics may be due to improper methods of cooking, they also may be due to improper handling.

ORGANOLEPTIC TESTS

Organoleptic tests or determination of quality through use of the senses of sight, touch, odor, and taste are the means most widely used to determine freshness of fish. Organoleptic tests can be divided into two categories; namely, the fundamental, and the accessory tests. The fundamental tests are those which measure factors directly responsible for the quality of the fish such as odor, flavor, appearance, and texture.

The accessory tests involve observations of characteristics which normally occur simultaneously with changes in quality but which are not directly involved. Such characteristics include the appearance of the eyes, gills, and viscera; and the amount and appearance of the slime, etc. These characteristics are not entirely reliable indices, but are convenient to determine. Thus, when purchasing fish in the round, the condition of the eyes and gills may be noted in order to predict the probable quality which cannot be determined definitely until the fish has been dressed, or cooked and tasted.

Chemical and bacteriological tests have also been promulgated which can be used when time permits. These tests are almost invariably of the accessory type, since they usually measure substances which form simultaneously with fish spoilage but which are at most only partially responsible for spoilage. Such tests have the advantage of determining the condition independent of the personal judgment of the observer, and which can be reproduced with considerable accuracy. In technological investigations they are often invaluable.

Their limitations are that they must always be carefully standardized against the fundamental organoleptic tests, and usually considerable time is needed before the results are obtained.

Whole fish.--Observations which can be made on whole fish are unfortunately limited to the accessory tests. Even tests for odor must be so classified since it is impossible to distinguish the odor of the flesh from that of the gills, slime, viscera, or other extraneous sources.

One of the most important observations which can be made upon whole fish is the presence and degree of rigor mortis. A fish is soft and flabby just after being removed from the water. Indentations made with the finger tips on the surface tend to remain. Soon after catching, the muscle proteins coagulate, and this causes a shortening of the muscle fibers and the development of the characteristic stiffness of rigor mortis. In extreme cases, the fish is stiffened into an arc and hardly can be straightened.

Fish which are in rigor mortis are almost certainly of excellent quality. Usually some decomposition is present in fish not in rigor mortis and other suitable tests will show the extent.

Anderson (1907)[3/] lists conditions under which rigor mortis is late in appearing and lasts longer; consequently, the fish keep better:

1. Fish in season.
2. Fish in health and vigorous condition.
3. Fish which are killed at once on capture.
4. Fish which are not only killed but pitted at the same time; that is, have the brain and spinal cord destroyed.
5. Fish gutted immediately upon capture.
6. Fish handled as little as possible after capture.
7. Fish kept at low temperature as when iced or kept in cold storage.

All of these conditions not only influence the length of rigor mortis, but are also factors in obtaining fish of high quality. The presence of full rigor mortis is not only an indication that the fish are absolutely fresh, but also that good handling methods have been used. Furthermore, rigor mortis is accompanied by an increase in the acidity of the muscular tissue and a setting of the flesh to a gel - like consistency, both factors which discourage bacterial invasion.

The odor of whole fish is another important index, but one which must be interpreted with care in order to avoid erroneous conclusions. Fresh fish usually have a characteristic fishy odor, somewhat similar to that of seaweed, and a fish which has just been taken from the water ordinarily has no other odor. Fish which are not eviscerated frequently give off odors suggestive of decomposition long before any spoilage of the flesh has taken place. This is usually caused by a rapid decomposition of the substances upon which the fish have been feeding. A pronounced hydrogen sulfide odor from this cause is sometimes present in fish which are less than six hours out of the water.

3/Anderson, A.G., 1907. On the decomposition of fish. Fish. Res. Bd. of Scotland, Rept. 26, pt. 3: 13-39.

The gills and slime of fish usually give off more pronounced decomposition odors than the flesh, and this fact is useful in predicting incipient decomposition. A fish in which the gills and slime have a perfectly fresh odor is apt to be in good condition while if the odor is stale, the fish itself may still be in good condition but will not remain so for long.

The degree of odor of fish is markedly affected by temperature. Thus, fish which are near the temperature of melting ice may have an imperceptible odor which might be increased to a relatively stale one, if the temperature of the fish were raised to ordinary room temperature.

The odor of fish kept in finely-packed ice ordinarily progresses from fishy through one of sweetness, to staleness, and finally becomes putrid. The latter is caused by such substances as hydrogen sulfide, indole, etc.

The eyes of fresh fish have a bright transparent appearance which becomes cloudy, and often assumes a pink color when fish are stale. When fish are fresh, the eyes often protrude, and with increasing staleness, they tend to sink. Gills of fresh fish are commonly bright red, and the color gradually fades to a light pink, then to a yellow, and finally, to a brown or sometimes a green shade. These changes in the eyes and gills do not always occur simultaneously with the spoilage of the flesh so they are not entirely reliable and the absence of such changes is not proof of the freshness of the fish.

Immediately after a fish is caught, it often exhibits a striking pearlescent appearance, if held so that the light strikes the fish at the correct angle. This "rainbow" effect somewhat resembles the appearance of pearls or some sea shells. The pearlescent appearance wears away relatively rapidly, so that any fish showing this characteristic is almost certainly in excellent condition. The absence of the pearlescent colors is no evidence of decomposition, since with some species, the beforementioned appearance is less striking, or it may be completely lacking.

Each species of fish has certain characteristic markings and colors. As the fish becomes stale, these patterns and colors fade and become less pronounced. Also, during the spawning season, the appearance may become somewhat abnormal with unusual colors often being observed.

The slime on fresh fish is transparent, almost water white, and usually not enough is present to be conspicuous except by the slimy feeling. As spoilage progresses, the slime increases in amount, becomes turbid and finally thick and often of a yellow color. Presence of such slime is good evidence that the fish is not fresh but its absence is meaningless, since it can easily be removed.

Dressed fish.--During the dressing operation, a number of observations can be made which are not possible with round fish. If the fish has not been eviscerated, the condition of the viscera may show some evidence of decomposition. Each organ, such as the heart or liver, is intact and easily recognizable. When extensive decomposition has occurred, the viscera may be an almost homogeneous mass in which one organ cannot be distinguished from another.

If the odor of the flesh is observed when the fish is first cut, and then again a short time later, the first odor is sometimes much stronger than the second. The first odor may represent an accumulation of gases, either from the flesh or from the contents of the viscera. The skin of fish is almost impervious to gases, so that a very small evolution in the body cavity over a

period of time may produce an odor which will lead to a wrong conclusion unless the odor is again noted a few minutes later.

The flesh between the viscera and the backbone of fresh fish is firm and sound. If the fish is handled in the round, the enzymes from the digestive system start to decompose the flesh in this region. Shortly after death, the flesh adjacent to the bone begins to soften and eventually may become almost entirely broken down so that a small amount of handling, such as occurs during filleting, causes the bone to separate from the flesh completely. These changes are sometimes accompanied by the formation of a peculiar yellowish gloss on the flesh near the backbone. This gloss sometimes described as an "apple jelly appearance" is suggestive of extensive decomposition.

Frequently, fish which have been held for some time show a reddening of the flesh near the backbone, and in the more advanced stages of decomposition, the color changes to a brown, as the hemoglobin is changed to methemoglobin.

The texture of fresh fish is firm and very little liquid can be expressed even when very heavy pressure is applied. As decomposition proceeds, the texture softens and sometimes fluid is spontaneously liberated. At the same time, the appearance of the flesh changes from a transluscent sheen to a dull luster. The color may also fade if the original shade is other than white, and, in the latter event, it may become somewhat yellow.

Cooked fish.--Since odors are more intense at high temperatures, it is not surprising that more intense odors are usually observed during the cooking of fish. Cooked fish, if fresh, has a pleasing flavor, characteristic for each species, and no aftertaste after eating. Fish of lower quality may have a variety of off-flavors. In some cases, the fish may lack some of the characteristic flavors without evidence of decomposition, and in this case, it is described as flat or tasteless. When only a small amount of decomposition is present, no difference in flavor may be noted, except possibly that there is a strong fishy or a slight "off" flavor. When more extensive decomposition has taken place, the "off" flavor may be described as acrid, bitter, stale, or even putrid. With oily fish, rancidity may lead to a persisting aftertaste, which, while perhaps not entirely disagreeable, is at least annoying.

Abnormal textures are also frequently noted in cooked fish. In some cases, the fish may be very soft, crumbling into small pieces when cut with a fork. In other instances, it may be tough, rubbery, or stringy.

Shellfish and crustacea.--Oysters, clams, crabs, and lobsters present somewhat different problems in determining freshness than is the case with fish. Oysters and clams, while still in the shell should be alive, and any evidence that this is not the case, such as loose or gaping shells is sufficient to cause their rejection. Mantles of oysters which are dry around the edge are evidence that the oysters are in poor condition. Sometimes a disagreeable odor is discerned at the surface of the oyster shell. Such odors may come from decay of vegetative debris adhering to the shell and are an indication that the oysters have been out of the water for some time even though the meats may still be in good condition.

Fresh, shucked oysters and clams have a characteristic fresh odor, and as deterioration takes place this changes to a sour odor which is caused by the formation of lactic acid. In very old products, the liquor may be turbid, and the meats may have a bleached appearance.

Crabs and lobsters should be alive at the time of butchering or cooking. The odor of the freshly picked meat from these species is normally a fairly pronounced sweetish or ammoniacal one, which, if present in other species, might be considered evidence of decomposition. Spoilage of these species takes place at a rate much greater than for other fish. The normal sweet to ammoniacal odor first increases to an intense sweet or strong volatile basic one and then often develops a sour, cheesy, stale, or even putrid smell in extreme spoilage. Owing to the rather pronounced initial odor of the fresh product it is difficult to detect incipient spoilage since this state is characterized merely by an intensification of the normal fresh odors, rather than by development of different types of odors as is more generally the case with other species.

Methods of making organoleptic tests.--In commercial marketing of fish, producers and wholesalers gain considerable experience over a period of time in judging the quality of fish by organoleptic means. The homemaker who only occasionally buys fish may have difficulty in accurately appraising quality, but by making the organoleptic tests outlined in the preceding sections anyone should soon be able to distinguish between the various stages of freshness with little or no difficulty.

In some types of examination as in the case of food inspection or in laboratory testing in connection with development of new products, or new methods of handling fish, it is sometimes necessary to be able to distinguish minute differences in quality. In such cases, it is often helpful to utilize observations of a large number of persons, and when this is done it is important that each observer make his examination independently and without knowledge of the findings of others. Some persons are unable to distinguish fine differences in odors or flavors, and if they attempt to judge the condition of fish, a rather erroneous appraisal is obtained. Under these circumstances, observers should be selected who have demonstrated their ability to obtain consistent results. Then, if an average is made of the observations of several persons, a very accurate estimate of the condition of the fish is obtained.

Estimation of keeping quality by organoleptic tests.--Appraisal of keeping quality of fish by organoleptic tests is much more difficult than the mere estimation of the quality at the time of examination. Future keeping quality of fish depends not only upon its present condition, but also upon past and future handling conditions. Although some idea of the handling conditions prior to examination may be obtained through careful interpretation of the organoleptic data, usually no certain prediction as to future storage conditions of the fish can be made except in the case of the ultimate consumer who will have possession of the fish continuously until it is eaten.

Fish which are already partially stale will certainly not keep in edible condition for a much longer time. It is ordinarily the fish which still seem to be in relatively good condition about which knowledge of future keeping quality is desired. Such fish may have been freshly caught, or they may have been kept well-iced for a considerable time. In the former case, assuming good future handling conditions will be used, the fish would be expected to keep for some time, while the keeping quality of the latter fish would be strictly limited. Accordingly, in predicting future keeping quality any indications that the fish had been stored for a considerable period are especially to be noted. For example, fish which have been iced for long periods often exhibit faded surface colors due to leaching. Another indication is a peculiar sweet odor which develops in fish held iced for extensive periods. This sweet odor is not considered especially undesirable, but since it is

usually not present in strictly fresh fish it may be taken as a warning of imminent spoilage.

Any indication that the fish have been roughly handled, such as loose scales, fork holes, bruises, or general softness of the fish, should be considered evidence of poor past handling conditions and probably poor future keeping quality. Fish that have been bruised are especially susceptible to autolytic changes which may lead eventually to sudden bacterial putrefaction. Finally, fish taken near the end of the spawning season keep less well than those taken at other times.

FEDERAL SPECIFICATIONS FOR PURCHASE OF FRESH FISH

Excerpts from the Detail Requirements of the specifications now in use by the U. S. Government in purchasing fish for consumption by the armed forces and other agencies follow:

PP-F-381b.--Fish, Fresh:

E-1. Type I. Fresh (not dressed).--Shall be thoroughly chilled at a temperature not lower than 32° F. by packing in clean, finely crushed ice immediately after catching or removal from the water and continuously maintained in a thoroughly chilled condition. Shall be strictly sound, fresh, and otherwise in prime condition at time of delivery.

E-2. Type II. Fresh, dressed.--Shall be prepared, handled, and delivered in the manner prescribed in paragraph E-1 for Type I, except that the fish shall be properly dressed by removal of scales, head, viscera, fins, blood clots in body cavity, and by thorough washing. Invitations for bids may specify that the head, fins or scales may be left on. Shall be strictly sound, fresh and otherwise in prime condition at time of delivery.

E-3. Type III. Fresh, fillets or steaks.--Shall be prepared, handled, and delivered in all applicable detail in the manner prescribed in paragraph E-1 for Type I, except that the fish shall be cut into fillets or steaks weighing not less than 3 nor more than 24 ounces each, provided, however, that in the case of species such as rosefish, whiting, and yellow perch, the minimum shall be not less than 1-1/3 ounces, as specified in the invitation for bids. Scraps will not be accepted. Shall be strictly sound, fresh, and otherwise in prime condition at time of delivery. Shall be packed in moisture-proof wrappers containing not more than 1½ lbs. of fish or single layer pack with moisture-proof material between layers.

E-4. Type IV. Frozen (not dressed).--Shall be strictly fresh and in prime condition at time of freezing; shall be frozen solid at the earliest practicable time after catching or removal from the water; and shall be continuously maintained in a solidly frozen condition, free from contamination, deterioration, and freezer burn; and shall be in prime condition at time of delivery.

E-5. Type V. Frozen, dressed.--Shall be Type II fish as defined above. Shall be frozen and handled in the manner prescribed for Type IV. Shall be properly dressed by removal of head, viscera, blood clots in body cavity, and by thorough washing, and shall be otherwise as provided in paragraph E-4 for Type IV.

E-6. Type VI. Frozen, fillets or steaks.--Shall be Type III fish as defined above. Shall be frozen and handled in the manner prescribed for Type IV.

PP-C-401.--Clams, Fresh:

E-1. Type I. Hard clams.--Shall be strictly fresh, hard-shell clams, of solid pack, averaging 150 to 170 to the gallon. The clams shall be delivered open with shells removed, shall be entirely free from admixture with water or chemical preservatives, and shall not have been placed in direct contact with ice.

E-2. Type II. Soft or soft-shell clams.--Shall be strictly fresh soft-shell clams, of solid pack, and shall be small, medium, or large as to size, as may be specified in the invitation for bids. The clams shall be delivered free from admixture with water or chemical preservatives, and shall not have been placed in direct cantact with ice.

PP-C-656.--Crabmeat, Fresh:

E-1. Shall be strictly from hard-shell crabs which have been properly cooked, shall be practically free from particles of shells and free from other substances than crab meat. Shall be wholesome and in every way fit for human consumption.

PP-O-956a.--Oysters, Fresh:

E-1. Shall be strictly fresh shucked oysters, solid pack. Shall be free from chemical preservatives and added water, and shall not have been placed in direct contact with ice.

E-2. The Bacillus coli score shall not be more than 50, according to the standard methods of the American Public Health Association.

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Other requirements include provisions that:

(1) All deliveries shall conform, in every respect, to the provisions of the Federal Food, Drug, and Cosmetic Act and regulations promulgated thereunder.

(2) Inspection shall be made at point delivery by the receiving agencies, unless otherwise specified.

(3) Chemical analyses if required by the purchaser in the examination or testing of samples and deliveries under the specifications, shall be made in accordance with methods of the Association of Official Agricultural Chemists in effect on date of invitation for bids.

Specifications governing the purchase of fresh and frozen shrimp and shrimp meat are in process of being promulgated.

Copies of the complete specifications may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents each.